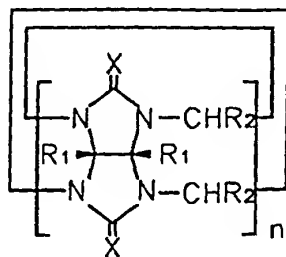


What is claimed is:

1. Cucurbituril derivatives having the formula (1)



...(1)

where X is O, S or NH; R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl groups of 1 to 30 carbon atoms, alkenyl groups of 1 to 30 carbon atoms, alkynyl groups of 1 to 30 carbon atoms, alkylthio groups of 1 to 30 carbon atoms, alkylcarboxyl groups of 1 to 30 carbon atoms, hydroxyalkyl groups of 1 to 30 carbon atoms, alkylsilyl groups of 1 to 30 carbon atoms, alkoxy groups of 1 to 30 carbon atoms, haloalkyl groups of 1 to 30 carbon atoms, nitro group, alkylamine groups of 1 to 30 carbon atoms, amine group, aminoalkyl groups of 1 to 30 carbon atoms, unsubstituted cycloalkyl groups of 5 to 30 carbon atoms, cycloalkyl groups of 4 to 30 carbon atoms with hetero atoms, unsubstituted aryl groups of 6 to 30 carbon atoms, and aryl groups of 6 to 30 carbon atoms with hetero atoms; and n is an integer from 4 to 20,

wherein the cucurbituril derivatives having the formula (1), where $n=6$, $R_1=H$, $R_2=H$ and $X=O$, and $n=5$, $R_1=CH_3$, $R_2=H$ and $X=O$, are excluded.

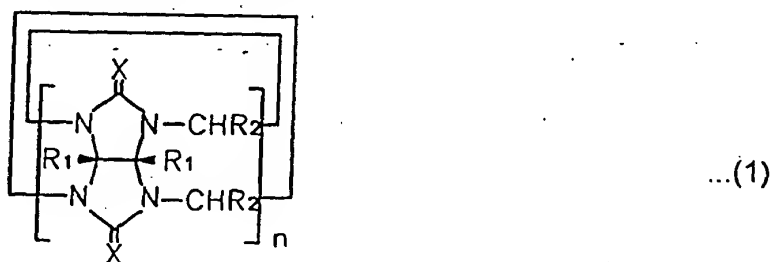
2. The cucurbituril derivatives of claim 1, wherein R_1 is methyl, ethyl, propyl, isopropyl, butyl, isobutyl, t-butyl, phenyl or pyridyl group, and R_2 is hydrogen, methyl, propyl, phenyl, trichloromethyl, trifluoromethyl, parafluorophenyl or α, α, α -trifluorotolyl group.

3. The cucurbituril derivatives of claim 1, wherein R_1 is hydrogen, and R_2 is methyl, ethyl, propyl, phenyl, trichloromethyl, trifluoromethyl, parafluorophenyl or α, α, α -trifluorotolyl group.

4. The cucurbituril derivatives of claim 1, wherein R_1 is methyl group, and R_2 is methyl, ethyl, propyl, phenyl, trichloromethyl, trifluoromethyl, parafluorophenyl or α, α, α -trifluorotolyl group.

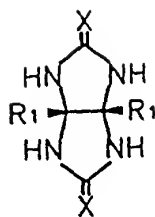
5. The cucurbituril derivatives of claim 1, wherein when $X=O$, R_1 and R_2 are both hydrogens, and $n=5$, or a value of 7 to 20, or when $X=NH$ or S, R_1 and R_2 are both hydrogens, and n is a value of 5 to 20.

6. A method for preparing cucurbituril derivatives having the formula (1)



where X is O, S or NH; R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl groups of 1 to 30 carbon atoms, alkenyl groups of 1 to 30 carbon atoms, alkynyl groups of 1 to 30 carbon atoms, alkylthio groups of 1 to 30 carbon atoms, alkylcarboxyl groups of 1 to 30 carbon atoms, hydroxyalkyl groups of 1 to 30 carbon atoms, alkylsilyl groups of 1 to 30 carbon atoms, alkoxy groups of 1 to 30 carbon atoms, haloalkyl groups of 1 to 30 carbon atoms, nitro group, alkylamine groups of 1 to 30 carbon atoms, amine group, aminoalkyl groups of 1 to 30 carbon atoms, unsubstituted cycloalkyl groups of 5 to 30 carbon atoms, cycloalkyl groups of 4 to 30 carbon atoms with hetero atoms, unsubstituted aryl groups of 6 to 30 carbon atoms, and aryl groups of 6 to 30 carbon atoms with hetero atoms; and n is an integer from 4 to 20, the method comprising:

(a1) adding 3 to 7 moles of an acid to 1 mole of compound (A) having the formula (A) to form a mixture, adding 2 to 20 moles of alkylaldehyde (B) having the formula (B) to the mixture, and stirring the mixture at 70 to 95°C; and



(A)



(B)

(b1) stirring the reaction product at 95 to 105°C to complete the reaction.

7. The method of claim 6, wherein the reaction product of step (b1) is a mixture of two or more cucurbituril derivatives having the formula (1) where n is a value from 5 to 20.

8. The method of claim 6, wherein the reaction product of step (b1) is a mixture of 5-30% of the cucurbituril derivative having $n=5$, 30-70% of the cucurbituril derivative having $n=6$, 5-30% of the cucurbituril derivative having $n=7$, 2-15% of the cucurbituril derivative having $n=8$, and 1-10% of the cucurbituril derivative having $n=9$ to 20.

9. The method of claim 6, further comprising the steps of:

(c1) recrystallizing the reaction product of step (b1) with water to obtain the cucurbituril derivative having the formula (1) with $n=8$;

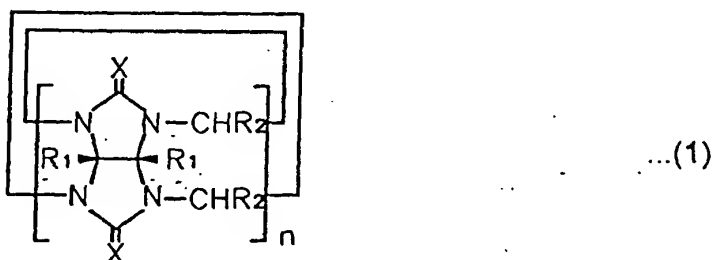
(d1) diluting the remaining solution after step (c1) with water and acetone to produce a precipitate which is filtered and further treated in step (e1), and removing the solvent from the resulting filtrate to obtain the cucurbituril derivatives having the formula (1), where n is a value from 9 to 20; and

(e1) partially dissolving the precipitate obtained in step (d1) in water to obtain the cucurbituril derivatives with $n=5$ and 7 from the water soluble fraction, and the cucurbituril derivative with $n=6$ from the water insoluble fraction.

10. The method of claim 9, wherein the water soluble fraction containing the cucurbituril derivatives with $n=5$ and 7, obtained in step (e1), is separated into the cucurbituril derivative having the formula (1) where $n=5$, and the cucurbituril derivative having the formula (1) where $n=7$, with a mixture of water and methanol.

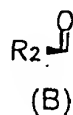
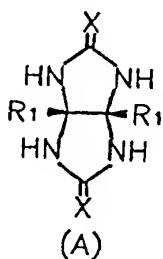
11. The method of claim 6, wherein the acid used in step (a1) is at least one selected from the group consisting of hydrochloric acid, sulfuric acid, phosphoric acid, acetic acid and nitric acid, and the acid is diluted with water or an organic in a concentration of 1 to 12M.

12. A method for preparing cucurbituril derivatives having the formula (1)



where X is O, S or NH; R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl groups of 1 to 30 carbon atoms, alkenyl groups of 1 to 30 carbon atoms, alkynyl groups of 1 to 30 carbon atoms, alkylthio groups of 1 to 30 carbon atoms, alkylcarboxyl groups of 1 to 30 carbon atoms, hydroxyalkyl groups of 1 to 30 carbon atoms, alkylsilyl groups of 1 to 30 carbon atoms, alkoxy groups of 1 to 30 carbon atoms, haloalkyl groups of 1 to 30 carbon atoms, nitro group, alkylamine groups of 1 to 30 carbon atoms, amine group, aminoalkyl groups of 1 to 30 carbon atoms, unsubstituted cycloalkyl groups of 5 to 30 carbon atoms, cycloalkyl groups of 4 to 30 carbon atoms with hetero atoms, unsubstituted aryl groups of 6 to 30 carbon atoms, and aryl groups of 6 to 30 carbon atoms with hetero atoms; and n is an integer from 4 to 20, the method comprising:

(a2) adding 0.1 to 1 moles of an acid to 1 mole of compound (A) having the formula (A) to form a mixture, adding 2 to 20 moles of alkylaldehyde (B) having the formula (B) to the mixture, and stirring the mixture at 70 to 85°C, to obtain an intermediate in a gel state; and



1
2 (b2) drying the intermediate in a gel state, adding 3 to 7 moles of an acid with
3 respect to 1 mole of the dried intermediate, and stirring the reaction product at 70 to
4 105°C.

1 13. The method of claim 12, wherein the reaction product of step (b2) is a
2 mixture of two or more cucurbituril derivatives having the formula (1) where n is a
3 value from 5 to 20.

1 14. The method of claim 12, wherein the reaction product of step (b2) is a
2 mixture of 5-30% of the cucurbituril derivative having $n=5$, 30-70% of the cucurbituril
3 derivative having $n=6$, 5-30% of the cucurbituril derivative having $n=7$, 2-15% of the
4 cucurbituril derivative having $n=8$, and 1-10% of the cucurbituril derivative having $n=$
5 9 to 20.

1 15. The method of claim 12, further comprising the steps of:
2 (c2) recrystallizing the reaction product of step (b2) with water and acetone to
3 obtain the cucurbituril derivative having the formula (1) with $n=8$;

4 (d2) diluting the remaining solution after step (c2) with water and acetone to
5 produce a precipitate which is filtered and further treated in step (e2), and removing
6 the solvent from the resulting filtrate to obtain the cucurbituril derivatives having the
7 formula (1), where n is a value from 9 to 20; and

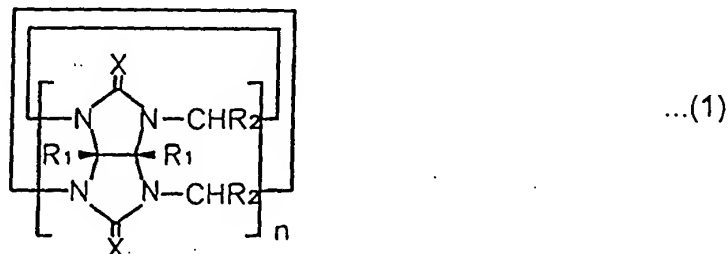
8 (e2) partially dissolving the precipitate obtained in step (d2) in water to obtain
9 the cucurbituril derivatives with $n=5$ and 7 from the water soluble fraction, and the
10 cucurbituril derivative with $n=6$ from the water insoluble fraction.

1 16. The method of claim 15, wherein the water soluble fraction containing
2 the cucurbituril derivatives with $n=5$ and 7, obtained in step (e2), is separated into the
3 cucurbituril derivative having the formula (1) where $n=5$, and the cucurbituril
4 derivative having the formula (1) where $n=7$, with a mixture of water and methanol.

1 17. The method of claim 12, wherein the acid used in step (a2) is at least
2 one selected from the group consisting of hydrochloric acid, sulfuric acid, phosphoric
3

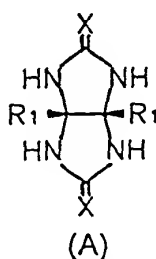
acid, acetic acid and nitric acid, and the acid is diluted with water or an organic in a concentration of 1 to 12M.

18. A method for preparing cucurbituril derivatives having the formula (1)



where X is O, S or NH; R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl groups of 1 to 30 carbon atoms, alkenyl groups of 1 to 30 carbon atoms, alkynyl groups of 1 to 30 carbon atoms, alkylthio groups of 1 to 30 carbon atoms, alkylcarboxyl groups of 1 to 30 carbon atoms, hydroxyalkyl groups of 1 to 30 carbon atoms, alkylsilyl groups of 1 to 30 carbon atoms, alkoxy groups of 1 to 30 carbon atoms, haloalkyl groups of 1 to 30 carbon atoms, nitro group, alkylamine groups of 1 to 30 carbon atoms, amine group, aminoalkyl groups of 1 to 30 carbon atoms, unsubstituted cycloalkyl groups of 5 to 30 carbon atoms, cycloalkyl groups of 4 to 30 carbon atoms with hetero atoms, unsubstituted aryl groups of 6 to 30 carbon atoms, and aryl groups of 6 to 30 carbon atoms with hetero atoms; and n is an integer from 4 to 20, the method comprising:

(a3) putting compound (A), and 0.1 to 1 moles of an acid and 2 to 20 moles of alkylaldehyde (B) with respect to 1 mole of compound (A), in a high-pressure reactor, reacting the mixture at 80 to 130°C, to obtain oligomers in powder form; and



(B)

(b3) adding 3 to 7 moles of an acid with respect to 1 mole of the oligomers, and stirring the mixture at 70 to 105°C.

1 19. The method of claim 18, wherein the reaction product of step (b3) is a
2 mixture of two or more cucurbituril derivatives having the formula (1) where n is a
3 value from 5 to 20.

1 20. The method of claim 18, wherein the reaction product of step (b3) is a
2 mixture of 5-30% of the cucurbituril derivative having $n=5$, 30-70% of the cucurbituril
3 derivative having $n=6$, 5-30% of the cucurbituril derivative having $n=7$, 2-15% of the
4 cucurbituril derivative having $n=8$, and 1-10% of the cucurbituril derivative having $n=$
5 9 to 20.

1 21. The method of claim 18, further comprising the steps of:
2 (c3) recrystallizing the reaction product of step (b3) with water and acetone to
3 obtain the cucurbituril derivative having the formula (1) with $n=8$;
4 (d3) diluting the remaining solution after step (c3) with water and acetone to
5 produce a precipitate which is filtered and further treated in step (e3), and removing
6 the solvent from the resulting filtrate to obtain the cucurbituril derivatives having the
7 formula (1), where n is a value from 9 to 20; and
8 (e3) partially dissolving the precipitate obtained in step (d3) in water to obtain
9 the cucurbituril derivatives with $n=5$ and 7 from the water soluble fraction, and the
10 cucurbituril derivative with $n=6$ from the water insoluble fraction.

1 22. The method of claim 21, wherein the water soluble fraction containing
2 the cucurbituril derivatives with $n=5$ and 7, obtained in step (e3), is separated into the
3 cucurbituril derivative having the formula (1) where $n=5$, and the cucurbituril
4 derivative having the formula (1) where $n=7$, with a mixture of water and methanol.

1 23. The method of claim 18, wherein, in step (a3), the pressure of the high-
2 pressure reactor is in the range of 15 to 100 psi.

1 24. The method of claim 18, wherein the acid used in the steps (a3) and
2 (b3) is at least one selected from the group consisting of hydrochloric acid, sulfuric

3 acid, phosphoric acid, acetic acid and nitric acid, and the acid is diluted with water or
4 an organic solvent in a concentration of 1 to 12M.

1 25. A use of the cucurbituril derivatives of any one of claims 1 through 24,
2 in removing organic dyes from waste water, heavy metal from water and radioactive
3 isotopes from radioactive wastes, in capturing and removing unpleasant odor, and air
4 pollutants including carbon monoxide, carbon dioxide, NO_x and SO_x, in
5 manufacturing sensors for sensing ammonium ions, organic amines, amino acid
6 derivatives, nucleic acid bases, alkali metal or alkaline earth metal ions, and in
7 separating and purifying fullerene or carborane compounds; and as additives to
8 polymers, cosmetics, artificially scented papers or textiles, pesticides, herbicides and
9 drugs, as drug carriers, as packing materials of chromatographic columns, as
10 additives to gas separation membranes, as catalysts for various chemical reactions.

1 26. The use of claim 25, wherein the cucurbituril derivatives are used as a
2 mixture of the cucurbituril derivatives produced in step (b1), (b2) or (b3) without
3 further separation.